

# MODULAR PLANT GROWING APPARATUS

## Field of the Invention

This invention relates to modular apparatus for use in growing plants by hydroponics or the like.

## Background of the Invention

In the field of growing plants, one common method used is known as hydroponics, or the cultivation of plants by placing the roots in a liquid nutrient solution rather than in soil, or the soilless growth of plants. In some instances a light soil or similar material (e.g. peat moss or even some man made materials) may be used to hold the roots but the primary nutrients are provided by solutions that are either added or in which the roots actually reside.

The major problem with this method of growing plants is the amount of area and equipment that is required. In most instances, a completely separate building is required with light and temperature control as well as containers for holding the plants and the nutrient solutions. This can be costly for start-ups and can severely limit the people who can

1 participate, since most of this type of growing will take place  
2 in cities or highly populated areas where there is insufficient  
3 area for standard farming techniques and, thus, limited area  
4 for the installation of normal hydroponic type growing.

5  
6 A large variety of hydroponics systems and methods of use  
7 are available or have been proposed. Most of these systems  
8 have serious limitations, such as the liquid circulation  
9 apparatus or limitations on the vertical or horizontal  
10 expansion of the systems. One prior art system, for example  
11 proposes a modular structure in which a lower module contains  
12 the liquid and a pump. The problem is, as the modules are  
13 stacked higher the pump must pump liquid farther and  
14 distribution of the liquid is very haphazard. In another prior  
15 art system a base contains the liquid supply and one or more  
16 columns extend vertically from the base. Liquid is pumped from  
17 the base through tubes to the top of the columns (one tube per  
18 column) and the liquid flows down across the roots of plants,  
19 residing in openings in the columns, and back into the base.  
20 Here the vertical height is limited to the height of the column  
21 and extra height cannot be added without completely changing  
22 the column.

23  
24 Another problem that arises in many of the prior art  
25 devices, is proper lighting. In many of the prior art plant  
26 growth units, different types and amounts of light may be

1 received by the plants in different positions. The differences  
2 in light quality and quantity may result in a divergence in  
3 growth and quality between plants grown at various levels and  
4 on various sides of the plant growth units.

5  
6 It would be highly advantageous, therefore, to remedy the  
7 foregoing and other deficiencies inherent in the prior art.

8  
9 Accordingly, it is an object of the present invention to  
10 provide new and improved modular apparatus for growing plants.

11  
12 Another object of the invention is to provide new and  
13 improved modular apparatus for growing plants by hydroponics or  
14 the like.

15  
16 And another object of the invention is to provide new and  
17 improved modular apparatus for growing plants in limited space.

18  
19 Still another object of the present invention is to  
20 provide new and improved modular apparatus for growing plants  
21 conveniently and with less start-up cost.

22  
23 Yet another object of the invention is to provide new and  
24 improved modular apparatus for growing plants in substantially  
25 any environment using very little space.

1           A further object of the present invention is to provide  
2   modular apparatus for growing plants that can be extended  
3   vertically and horizontally substantially as far and in any  
4   shape desired.

## Summary of the Invention

Briefly, to achieve the desired objects of the instant invention in accordance with a preferred embodiment thereof, provided is modular plant growing apparatus including a housing with inner and outer walls, opposed side walls, a bottom wall, and a top wall interconnected to form an enclosure. A liquid nutrient solution reservoir is formed, at least partially by the bottom wall and the inner and outer walls in the enclosure. At least one of the inner and outer walls includes plant supporting structure with plant receiving openings extending from external to the enclosure to internal to the enclosure. A pump is positioned in liquid communication with the reservoir. A manifold and distribution conduits are in liquid communication with the pump and constructed and positioned to supply liquid nutrient solution from the reservoir to at least roots of plants positioned in the plant supporting structure.

## Brief Description of the Drawings

The foregoing and further and more specific objects and advantages of the instant invention will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment thereof taken in conjunction with the drawings, in which:

FIG. 1 is a top isometric view of one arrangement of modular plant growing apparatus in accordance with the present invention;

FIG. 2 is a top isometric view of another arrangement of modular plant growing apparatus in accordance with the present invention;

FIG. 3 is an inner, top isometric view, of a single corner module in accordance with the present invention (note that plant receiving openings are illustrated as dimples for simplicity of understanding in FIGS. 3 through 19);

FIG. 4 is a top plan view of the single corner module of FIG. 3;

FIG. 5 is an inner side view of the single corner module of FIG. 3;

1        FIG. 6 is a left-hand inner, bottom isometric view of a  
2        single straight module in accordance with the present  
3        invention;

4  
5        FIG. 7 is an outer, bottom isometric view of the single  
6        straight module of FIG. 6;

7  
8        FIG. 8 is a right-hand inner, top isometric view of the  
9        single straight module of FIG. 6;

10  
11       FIG. 9 is an inner side plan view of the single straight  
12       module of FIG. 6;

13  
14       FIG. 10 is a top plan view of the straight module of FIG.  
15       9;

16  
17       FIG. 11 is a bottom plan view of the straight module of  
18       FIG. 9;

19  
20       FIG. 12 is a left side plan view of the straight module of  
21       FIG. 9;

22  
23       FIG. 13 is a right side plan view of the straight module  
24       of FIG. 9;

1           FIGS. 14 through 19 are views similar to FIGS. 8 through  
2   13, respectively, of an alternate embodiment;

3

4           FIG. 20 is an inner, top isometric view of four modules  
5   interconnected modules, in accordance with the present  
6   invention;

7

8           FIG. 21 is an inner, bottom isometric view of the four  
9   inner connected modules of FIG. 20, with the outer shell  
10  removed;

11

12          FIG. 22 is an outer, top isometric view of the four inner  
13  connected modules of FIG. 20; and

14

15          FIG. 23 is an outer, top isometric view of the four inner  
16  connected modules of FIG. 20 (similar to FIG. 22), with the  
17  outer wall removed to illustrate internal components.



## Detailed Description of the Preferred Embodiments

Turning now to the drawings in which like reference characters indicate corresponding elements throughout the several views, attention is first directed to FIG. 1, which illustrates one arrangement 10 for modular plant growing apparatus in accordance with the present invention. As can be seen from FIG. 1, arrangement 10 results in a substantially circular configuration. A second arrangement 12 for modular plant growing apparatus in accordance with the present invention is illustrated in FIG. 2. As can be seen from FIG. 2, arrangement 12 results in a substantially elliptical configuration, which may be completely enclosed or not, as desired for convenience. The modules of FIGS. 1 and 2 are illustrated in a somewhat simplified form, since the figures are only intended to illustrate two of the variety of arrangements that can be formed using the modules of the present invention. It is preferred that the arrangements are generally designed to afford relatively uniform light quality and quantity from any light source or sources to all plants residing in the arrangement. Also, the number of modules that may be included in the arrangement is determined only by the convenience and the specific application, circumstances, or conditions.

1        Referring to FIGS. 3, 4, and 5, an inner, top isometric  
2        view, top plan and inner plan view, respectively, illustrate a  
3        single corner module 20, in accordance with the present  
4        invention. Corner module 20 includes an inner wall 22, an  
5        outer wall 24, opposed side walls 25 and 26, a bottom wall 27,  
6        and a top wall 28 interconnected to form an enclosure. A  
7        liquid nutrient solution reservoir is formed at the bottom of  
8        the enclosure, at least partially by bottom wall 27, inner wall  
9        22, and outer wall 24, as will be explained and illustrated in  
10       more detail below. In this embodiment, inner wall 22 includes  
11       plant supporting structure 30 with plant receiving openings  
12       (illustrated as dimples in these figures for simplicity)  
13       extending from external to the enclosure to internal to the  
14       enclosure.

15  
16       In this embodiment, plant supporting structure 30 is  
17       formed by corrugating inner wall 22 to form a plurality of  
18       vertically separated, alternate generally V-shaped ridges 32  
19       and depressions 34. The alternate ridges 32 and depressions 34  
20       extended horizontally in an arcuate configuration so that a  
21       lower surface 36 of each depression 34 (or ridge 32) is  
22       directed generally inwardly and upwardly toward a locus of the  
23       arc. Further, in the preferred embodiment, lower surface 36  
24       forms an angle of approximately 90 degrees with an upper  
25       surface 38. A plurality of horizontally spaced apart dimples  
26       37 are positioned in each lower surface 36. Plant receiving

1 openings extending from external to the enclosure to internal  
2 to the enclosure are formed at each dimple 37, as will be  
3 described in more detail below.

4  
5 Side wall 25 includes coupling protrusions 40, which in  
6 this embodiment include a pair of oval-shaped wall extensions.  
7 Side wall 26 includes coupling openings 42, which in this  
8 embodiment include a pair of oval-shaped wall depressions  
9 designed to mate with coupling protrusions 40 on a coupled  
10 module located horizontally adjacent module 20. Bottom wall 27  
11 includes coupling protrusions 44, which in this embodiment  
12 include circular-shaped feet. Top wall 28 includes coupling  
13 openings 46, which in this embodiment include circular-shaped  
14 openings positioned to mate with coupling protrusions 44 on a  
15 coupled module located vertically adjacent module 20. Thus, a  
16 plurality of modules 20 can be arranged, for example, as  
17 illustrated in arrangement 10 of FIG. 1 and held firmly in  
18 position, horizontally by mating protrusions 40 and openings 42  
19 and held firmly in position, vertically by mating protrusions  
20 44 and openings 46. It will be understood that, while a  
21 specific configuration and position for the protrusions and  
22 mating openings have been illustrated for purposes of this  
23 explanation, other configurations may be devised.

24  
25 Turning now to FIGS. 6 through 13, a single straight  
26 module 50, in accordance with the present invention, is

1 illustrated in the several views. Straight module 50 includes  
2 an inner wall 52, an outer wall 54, opposed side walls 55 and  
3 56, a bottom wall 57, and a top wall 58 interconnected to form  
4 an enclosure. A liquid nutrient solution reservoir is formed  
5 at the bottom of the enclosure, at least partially by bottom  
6 wall 57, inner wall 52, and outer wall 54, as will be explained  
7 and illustrated in more detail below. In this embodiment,  
8 inner wall 52 includes plant supporting structure 60 with plant  
9 receiving openings (illustrated as dimples in these figures for  
10 simplicity) extending from external to the enclosure to  
11 internal to the enclosure.

12  
13 In this embodiment, plant supporting structure 60 is  
14 formed by corrugating inner wall 52 to form a plurality of  
15 vertically separated, alternate generally V-shaped ridges 62  
16 and depressions 64. The alternate ridges 62 and depressions 64  
17 extended horizontally in a straight configuration so that a  
18 lower surface 66 of each depression 64 (or ridge 62) is  
19 directed generally outwardly and upwardly. Further, in the  
20 preferred embodiment, lower surface 66 forms an angle of  
21 approximately 90 degrees with an upper surface 68. A plurality  
22 of horizontally spaced apart dimples 67 are positioned in each  
23 lower surface 66. Plant receiving openings extending from  
24 external to the enclosure to internal to the enclosure are  
25 formed at each dimple 67, as will be described in more detail  
26 below.

1  
2         Side wall 55 includes coupling protrusions 70, which in  
3 this embodiment include a pair of oval-shaped wall extensions.  
4 Side wall 56 includes coupling openings 72, which in this  
5 embodiment include a pair of oval-shaped wall depressions  
6 designed to mate with coupling protrusions 70 on a coupled  
7 module located horizontally adjacent module 50. Bottom wall 57  
8 includes coupling protrusions 74, which in this embodiment  
9 include circular-shaped feet. Top wall 58 includes coupling  
10 openings 76, which in this embodiment include circular-shaped  
11 openings positioned to mate with coupling protrusions 74 on a  
12 coupled module located vertically adjacent module 50. Thus, a  
13 plurality of modules 50, or other modules such as modules 20,  
14 can be arranged, for example, as illustrated in arrangement 12  
15 of FIG. 2 and held firmly in position, horizontally by mating  
16 protrusions 70 and openings 72 and held firmly in position,  
17 vertically by mating protrusions 74 and openings 76. It will  
18 be understood that, while a specific configuration and position  
19 for the protrusions and mating openings have been illustrated  
20 for purposes of this explanation, other configurations may be  
21 devised.

22  
23         Referring additionally to FIGS. 14 through 19, another  
24 embodiment of a single straight module 50', in accordance with  
25 the present invention, is illustrated in the several views.  
26 Components in module 50' that are similar to components in

1 module 50 (described above) are designated by the same number  
2 with a prime added to indicate the different embodiment.  
3 Module 50' is constructed substantially similar to module 50,  
4 except that in module 50' outer wall 54' is corrugated, similar  
5 to inner wall 52'. Thus, in this embodiment, both inner wall  
6 52' and outer wall 54' include plant supporting structure 60'.  
7 It will be understood that plant supporting structure 60' of  
8 inner wall 52' and outer wall 54' will generally use separate  
9 light sources for plant growth so that this specific embodiment  
10 is useful for specially applications and probably would not be  
11 included in an arrangement like arrangement 12 of FIG. 2.  
12 However, modules 50' can still be stacked and coupled both  
13 vertically and horizontal.

14  
15 It will be understood that any of the modules disclosed,  
16 including modules 20, 50, and 50', can be fabricated using any  
17 of a variety of methods. In the preferred embodiment the inner  
18 wall, the opposed side walls, and the bottom and top walls  
19 (e.g. inner 22, opposed side walls 25 and 26, bottom wall 27,  
20 and top wall 28) are formed in one integral unit, with the  
21 outer wall (e.g. outer wall 24) attachable by adhesive,  
22 welding, clamps, or the like. All or any portion of the  
23 modules can be formed of plastic, metal, or any other  
24 convenient material and the modules can be fabricated by  
25 molding, or any other convenient process. Since the lower  
26 portion of a module may be used as a liquid reservoir, it is

1 desirable that at least the lower portion of the inner wall,  
2 the opposed side walls, the bottom wall, and the outer wall be  
3 substantially liquid leak proof.

4  
5 Referring to FIGS. 20 and 21, four modules, in accordance  
6 with the present invention, are interconnected to form a  
7 portion of an arrangement, such as arrangement 12 depicted in  
8 FIG. 2. The four modules include a curved module 20 and a  
9 straight module 50 connected together, in this specific example  
10 to form a common unit with two common units stacked vertically  
11 in this example. Each of the modules 20 and 50 are connected  
12 and positioned so that inner walls 32 and 52 are directed  
13 inwardly and surfaces 36 and 66 of plant supporting structures  
14 30 and 60 extend horizontally in substantially continuous rows.  
15 Plant receiving openings 80 are formed at the location of each  
16 dimple 37 and 67. In this embodiment, the lowest lower surface  
17 36 and 66 in at least the lower modules 20 and 50 do not have  
18 plant receiving openings formed therein so that the lower  
19 portion of each lower module 20 and 50 serves as a reservoir  
20 for liquid nutrient solutions.

21  
22 Referring additionally to FIG. 22, outer walls 24 and 54  
23 of modules 20 and 50, respectively, are illustrated. Each  
24 outer wall 24 and 54 of each module 20 and 50, respectively,  
25 includes a clear access window 82 mounted to be removable or  
26 hinged to provide viewing and access to the internal enclosure.

1 It will be understood that an opaque access panel can be  
2 employed instead of clear access window 82. For example,  
3 liquid may be introduced, or maintained at a desirable level,  
4 by introducing the liquid through access window 82. Also, each  
5 outer wall 24 and 54 of each module 20 and 50, respectively,  
6 includes a liquid level indicator 84 viewable from the exterior  
7 of the internal enclosure so that the level of the liquid can  
8 be conveniently maintained without disturbing the plants. An  
9 electrical access opening 86 is provided in each outer wall 24  
10 and 54 for the extension of an electric line from a pump, to be  
11 discussed presently. While all modules 20 and 50 in the  
12 arrangement illustrated in FIG. 22 do not necessarily include a  
13 liquid reservoir or a pump, in the preferred embodiment,  
14 modules 20 and 50 are manufactured as standard modules and,  
15 thus, some features may be included that are not necessarily  
16 used in all applications.

17  
18 In this embodiment three corrugations 42 are formed in  
19 each module but it will be understood that any number of  
20 corrugations, from one to as many as can be conveniently used,  
21 can be incorporated generally depending upon the size and shape  
22 of the modules. Each corrugation has openings 80 therein  
23 (except for the reservoir forming corrugations) for receiving  
24 plant carrying devices. Here it will be understood that plant  
25 carrying devices can be any convenient means of supporting  
26 plants in openings 80, including but not limited to porous



1 plastic baskets, peat moss baskets, wire baskets or holders,  
2 etc. Also, it will be understood that the corrugations could  
3 be constructed to hold plants without the use of extra baskets,  
4 in some special applications.

5  
6 Referring additionally to FIG. 23, a rear view of the four  
7 module arrangement, similar to FIG. 22, is illustrated with  
8 outer walls 24 and 54 of each module 20 and 50 removed to show  
9 the internal enclosure and components. In this four module  
10 arrangement, a pump 85 is located so as to be in communication  
11 with liquid in one reservoir, in this example the lower module  
12 20. Pump 85 can be a submersible type or one that communicates  
13 with the reservoir through a connecting tube. Here it should  
14 be understood that the liquid nutrient solution in the  
15 reservoir is generally at some convenient level below the  
16 second corrugation in the lower modules. Also, it is  
17 preferable that reservoirs in adjacent modules are in liquid  
18 communication so as to provide continuous circulation  
19 therethrough. Generally, pump 85 is an electric pump that is  
20 connected by insulated and liquid proof wires (not shown) that  
21 extend through an electrical access opening 86 in outer wall 24  
22 or 54 (above the level of the liquid nutrient solution), as  
23 illustrated in FIG. 22, external to module 20 or 50 so as to  
24 plug into a convenient wall socket, for example.

1       A liquid manifold 87 extends vertically along the inner  
2 surface of side wall 55 of lower module 50, through an opening  
3 formed for that purpose in top wall 58 of lower module 50,  
4 through an opening formed for that purpose in bottom wall 57 of  
5 upper module 50, and along the inner surface of side wall 55 of  
6 upper module 50. Distribution conduits 88 extend from manifold  
7 87 horizontally adjacent the undersurface of each lower surface  
8 36 in modules 20, through openings in the sides of modules 20  
9 and 50, and adjacent the undersurface of each lower surface 66  
10 in modules 50. Distribution conduits 88 include spray nozzles  
11 90 situated to spray liquid nutrient solution onto the roots of  
12 plants in openings 80, generally one nozzle 90 per opening 80.  
13 Spray nozzles 90 may be directional, semi-directional, or omni-  
14 directional separate components mounted in openings in  
15 distribution conduits 88 or they may simply be very small  
16 misting type openings formed directly in distribution conduits  
17 88.

18  
19       Here it is convenient to note that the corrugations in  
20 modules 20 and 50 are constructed so that lower surfaces 36 and  
21 66, respectively, and upper surfaces 38 and 68, respectively,  
22 form an angle (in this preferred embodiment approximately 90  
23 degrees) that conveniently allows the roots to be exposed below  
24 surfaces 36 and 66 for convenient application of liquid  
25 nutrient solution, while the plants extend above surfaces 36  
26 and 66 so as to receive maximum light and growing room. In

1     general, the angle should be formed so that upper surfaces 38  
2     and 68 retain moisture from distribution conduits 88 and  
3     nozzles 90 (if present) within the enclosure while not  
4     interfering with plant growth.

5  
6         In the preferred embodiment liquid manifold 87 is formed  
7     of  $\frac{1}{2}$  inch plastic tubing but it will be understood that other  
8     materials and appropriate sizes may be used. Also,  
9     distribution conduits 88 include  $\frac{1}{4}$  inch plastic tubing but it  
10    will be understood that other materials and appropriate sizes  
11    may be used. Thus, manifold 87 and distribution conduits 88  
12    are connected into a continuous system for carrying liquid  
13    nutrient solution from the reservoir to the roots of plants  
14    residing in openings 80 in all four modules of the arrangement.  
15    Generally, pump 85 may run continuously or at timed intervals  
16    to ensure sufficient liquid nutrient solution on the roots of  
17    the plants, depending at least in part on the construction or  
18    makeup of modules 20 and 50, the numbers coupled together, and  
19    the surrounding atmosphere. It will be understood that the  
20    liquid distribution system disclosed for the four module  
21    arrangement can be used to distribute liquid within all of the  
22    modules in, for example, the arrangements illustrated in FIGS.  
23    1 and 2, if desired. Also, in some specific applications it  
24    may be inconvenient to use a single pump 85 and interconnected  
25    reservoirs, in which case a pump and manifold can be included

1 in each separate module 20 or 50, or in each separate vertical  
2 stack of modules 20 or 50.

3  
4 Thus, new and improved modular apparatus for growing  
5 plants has been disclosed. The new and improved modular  
6 apparatus is used, generally, for growing plants by hydroponics  
7 or the like. Further, the new and improved modular apparatus  
8 is convenient for growing plants in limited space and with less  
9 start-up cost. Utilizing the new and improved modular  
10 apparatus, growing plants in substantially any environment  
11 using very little space can be easily and inexpensively  
12 accomplished. To this end, modules are disclosed that can be  
13 used individually or in any desired horizontal and vertical  
14 arrangement. The modular entire apparatus is constructed to  
15 conveniently plug into and operate from, for example, a  
16 standard electrical wall socket.

17  
18 Various changes and modifications to the embodiments  
19 herein chosen for purposes of illustration will readily occur  
20 to those skilled in the art. To the extent that such  
21 modifications and variations do not depart from the spirit of  
22 the invention, they are intended to be included within the  
23 scope thereof which is assessed only by a fair interpretation  
24 of the following claims.

1           Having fully described the invention in such clear and  
2   concise terms as to enable those skilled in the art to  
3   understand and practice the same, the invention claimed is: